MEMORANDUM

SUBJECT: Back-Scatter Electron Microscopy for Sediment Samples

FROM: Laura Buelow, EPA

TO: Kris McCaig, Teck American, Inc.

Summary
EPAs level of effort (LOE) for Phase 2 sediment sampling at the UCR included submitting samples for back-scatter electron microscopy (BSEM; a potential measure of slag content in sediment). Teck (TAI) proposed 38 samples for this analysis. EPA requests that 4 new samples be included in addition to those proposed by TAI. A brief discussion on the selection of these samples is shared below.

DQOs

- Data Quality Objectives (DQOs) for this analysis were to:

    1) Calibrate the metal ratio approach for slag characterization; and,
    2) As an explanatory variable for interpreting sediment tox results.

    "Can the nature and extent of unacceptable risk at the Site via spatial gradients and sediment bed properties such as slag content (e.g., Zn/V), TOC, mPECQ, and sediment texture be further refined?

    The adequacy of multiple metal ratio methods for describing sediment bed properties such as slag content will be evaluated by using field observations (e.g., presence/ absence and percent of visible black silica glass particles) in conjunction with sediment chemistry. Sediment samples will be archived and no fewer than 35 samples will undergo backscatter electron microscopy following a review of the preliminary data. Samples will be selected for this specialized work following a review of the preliminary chemistry data; and will be documented in a technical memorandum, or QAPP addendum, for EPA's review and approval."

- Samples were to be selected upon the basis of a range of predicted slag content as determined by metal ratios.

TAIs Proposed Samples

- Preliminary analytical data were evaluated in consideration of TAIs proposed samples for BSEM.
- TAI proposed 38 samples for BSEM of the 137 available samples (letter from K. McCaig to L. Buelow on 2/25/14). Most samples with field observations of visual slag were selected (29 of the 32). Most (32 of 38) samples were also from the riverine reaches (i.e., upstream of Kettle Falls).
- TAIs proposed samples are generally skewed for variables assessed (e.g., TOC, mPECQ, Zn/V, and Cu/Al, river mile). This is likely due to TAI selecting samples with visual slag - which are typically associated with the riverine reaches that were generally sandy.
- Including additional samples will improve our ability to meet DQOs.
    - Samples without visually observed slag will improve our understanding of how backscatter can identify slag characteristics when slag is not visible; and/or,
    - Samples that were also submitted for bioassays provide another variable to interpret dose-responses (dependent on toxicity data - currently unavailable).

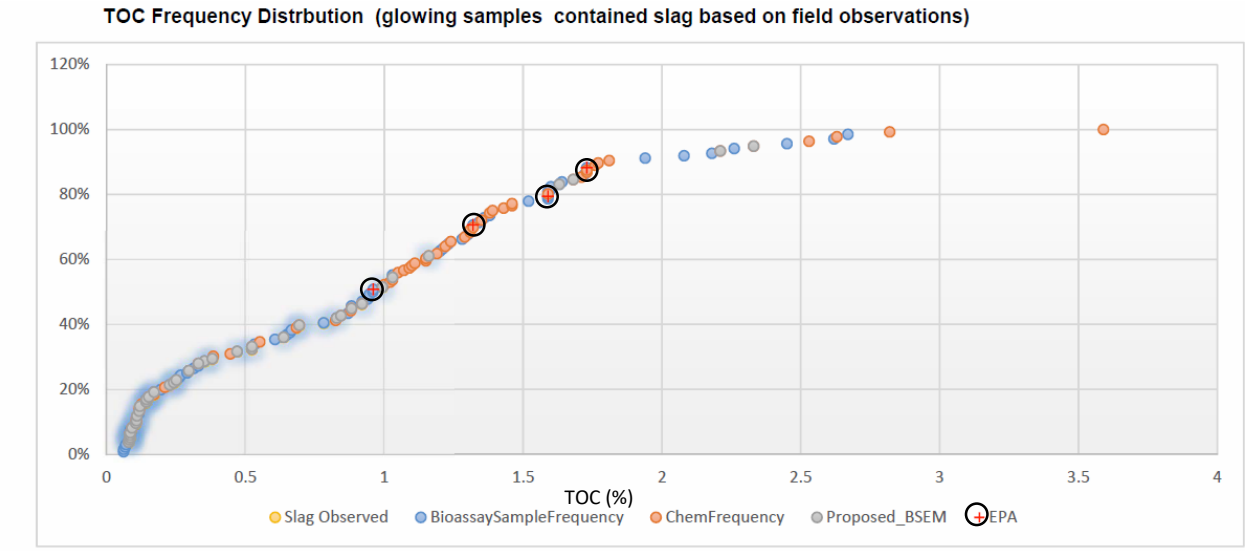
Requested Additional Analyses

EPA requests 4 additional samples be included with those proposed by TAI for BSEM analysis. LAL-5 represents a sample from an external reference site, sample 6-B4 represents a sample from Focus Area 6, and samples 5-B2 and REF-3 are samples from Focus Area 5.

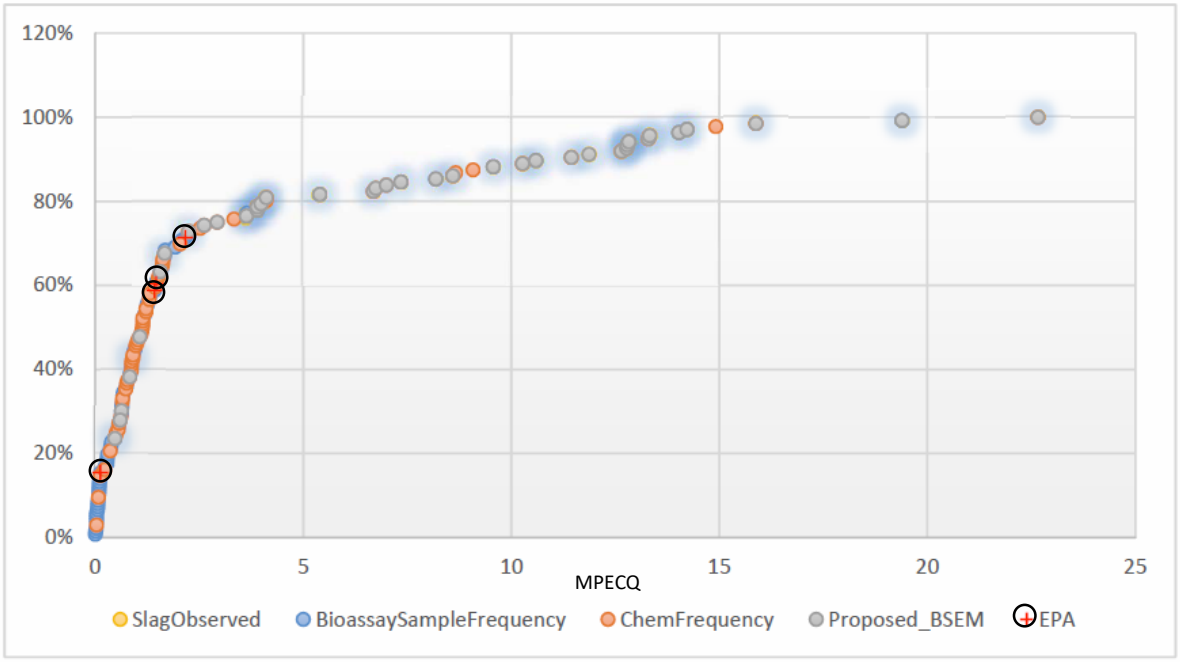
Sediment Characteristics of the 4 alternative samples for BSEM requested by EPA

Sample	*RM*	*Visual Slag (%)*	*TOC (%)*	*mPECQ4*	*Silt (%)*	*Clay (%)*	*Medium Sand (%)*	*Zn:V*	*Cu:Al*	*Notes*
6-B4	665	0	1.3	1.4	61	23	2.3	18	0.0025	From Focus Area 6.
LAL-5	Canada	0	1.7	0.14	19	19	1.3	2.3	0.00195	Canadian reference site
5-B2	678	0	1.59	2.2	57	39	1	18.7	0.0044	From Focus Area 5.
REF-3	689	0	0.961	1.5	40	12	8	19.0	0.0047	From Focus Area 5.

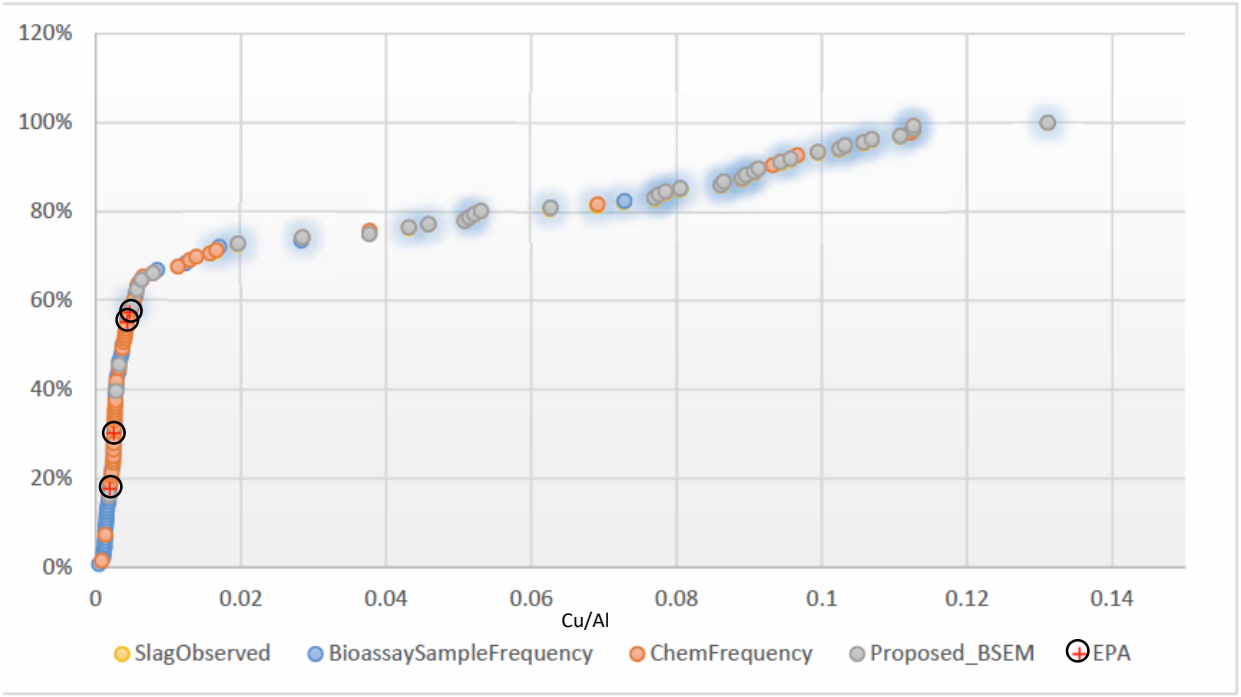
Together, these four additional samples will help meet the goal of validating visual and metal ratio methods for describing slag content as they do not have visible slag; they were sampled in reaches not described by other samples proposed for BSEM, and they cover a broader range of sediment characteristics than the TAI samples proposed for BSEM (e.g., where TOC was between 1-2.1 percent, or >2.5 percent; and, mPECQ ranged between 1-1.5 or was <0.25; see figures).



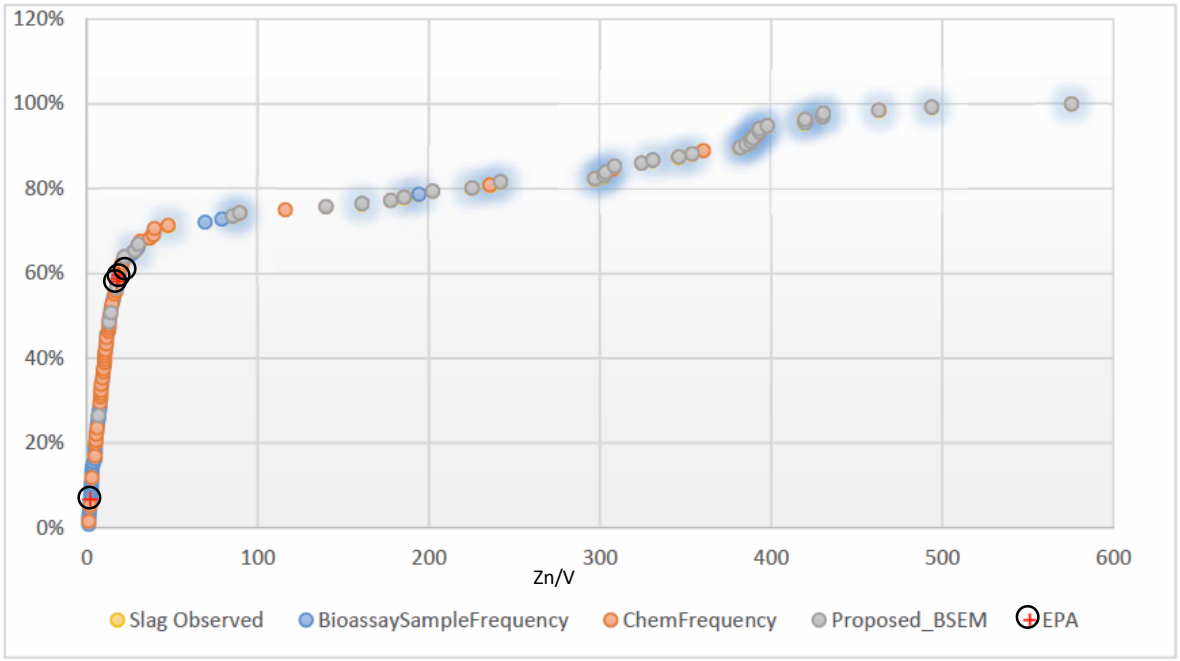
MPECQ4 Frequency Distrbution (glowing samples contained slag based on field observations)



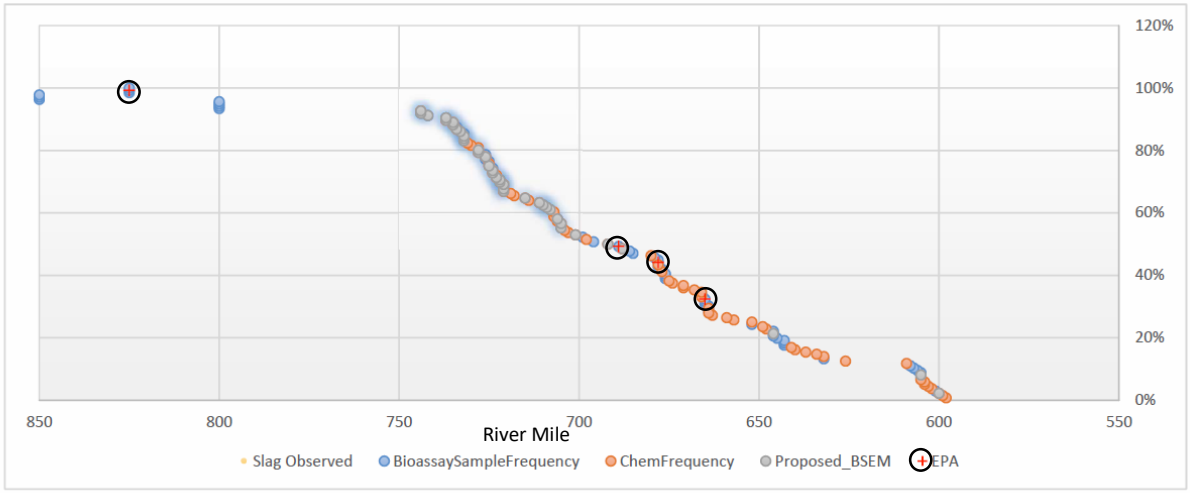
Cu/Al Frequency Distrbution (glowing samples contained slag based on field observations)

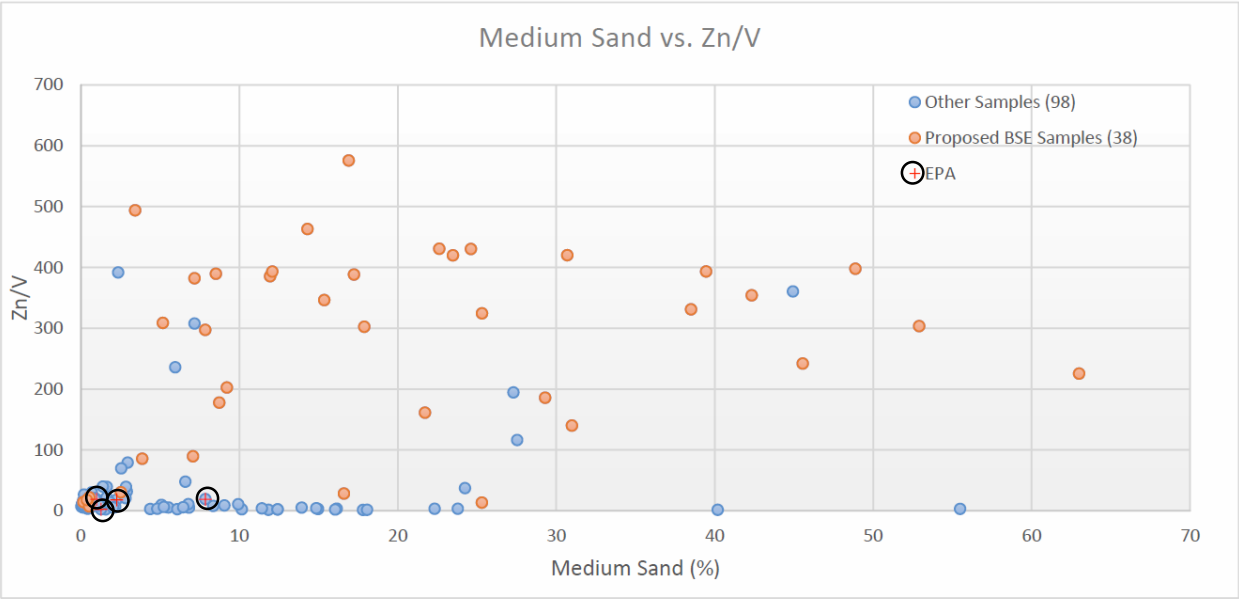


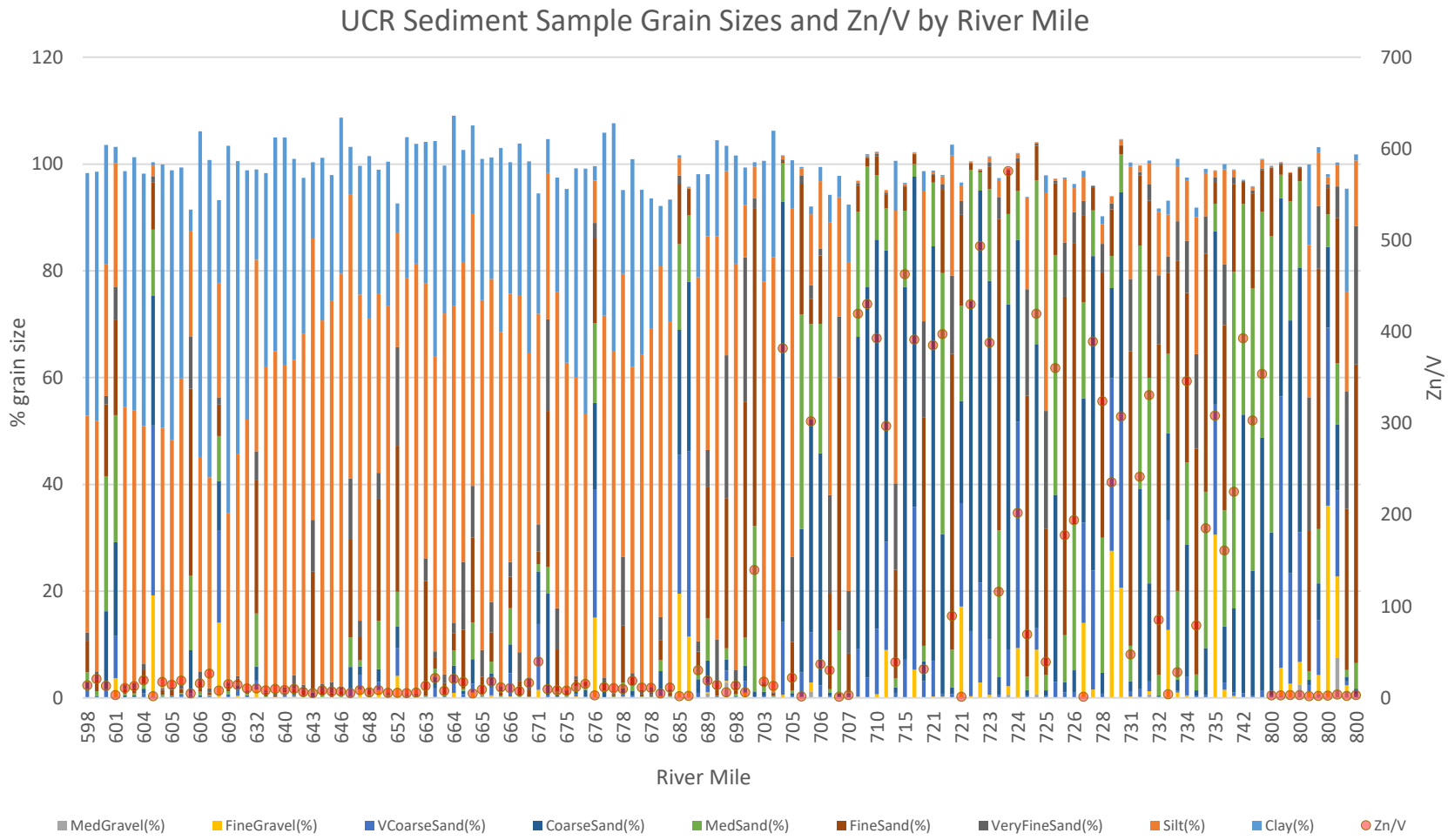
Zn/V Frequency Distrbution (glowing samples contained slag based on field observations)



BSE Sampling Frequency Distrbution by River Mile (glowing samples contained slag based on field observations)




Medium Sand vs. Zn/V
Other Samples (98)
Proposed BSE Samples (38)
EPA
Zn/V
Medium Sand (%)
0
100
200
300
400
500
600
700
0
10
20
30
40
50
60
70


UCR Sediment Sample Grain Sizes and Zn/V by River Mile
% grain size
Zn/V
River Mile
120
100
80
60
40
20
0
700
600
500
400
300
200
100
0
598
601
604
605
606
609
632
640
643
646
648
652
663
664
665
666
671
675
676
678
678
685
689
698
703
705
706
707
710
715
721
721
723
724
725
726
728
731
732
734
735
742
800
800
800
800
MedGravel(%)
FineGravel(%)
VCoarseSand(%)
CoarseSand(%)
MedSand(%)
FineSand(%)
VeryFineSand(%)
Silt(%)
Clay(%)
Zn/V